FFI
FEAT FIREMON Integration Database Tool Design

Prepared by

FEAT FIREMON Integration Design Team

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Introduction

This document serves to define the FEAT (Fire Ecology Assessment Tool) FIREMON (Fire Effects Monitoring and Inventory System) Integration (FFI) software tool design requirements. The intended audience includes project stakeholders and potential software developers.

The FIREMON and FEAT Integration Design Team developed this document, which was first submitted as Version 1 on July 1, 2005. This second release of the design document resolves issues that were identified in the initial design. Team representatives include system developers for FEAT and FIREMON, National Park Service agency representatives, and Michele Tae of Commonthread Incorporated, the contractor for the FEAT FIREMON Integration Feasibility Study. The Interagency Fuels Group sponsored the FFI project under the direction of the following business leads:

- **Nate Benson**: Fire Ecologist Program Leader, USDI, National Park Service, National Interagency Fire Center, Boise, Idaho, 208-387-5219
- **Bev Schwab**: Fire Effects Specialist, USDI, Bureau of Indian Affairs, National Interagency Fire Center, Boise, Idaho, 208-387-5042
- **Tim Sexton**: Fire Use Program Manager, USDA, Forest Service, National Interagency Fire Center, Boise, Idaho, 208-387-5223
- **Doug Havlina**: Fire Ecologist, BLM, USDI, National Interagency Fire Center, Boise, Idaho, 208-387-5061
- **Karen A Murphy**: Regional Fire Ecologist, USDI, Fish and Wildlife Service, 1011 E. Tudor Road, Anchorage, Alaska 99503, 907-786-3501

This document describes the FFI application design elements at a high level. Detailed design decisions will be included in the software development project that will follow.

Business Case

FFI intends to integrate the FIREMON and FEAT software systems into a single software tool. Both FEAT and FIREMON facilitate fire ecology monitoring and have similar procedural and database architectural characteristics. Each system includes unique functions, such as geospatial support and analysis tools, that the FFI project can combine into one integrated system. This integration will result in an enhanced monitoring tool that will accommodate data collection and support cooperative, interagency data management and information sharing.

FFI will support fire effects monitoring for all federal land management agencies at the field and research level, scalable from a site specific level to the landscape level. This tool will support other natural resource applications, such as satellite imagery classification, vegetation, aquatic habitat, fisheries, and wildlife monitoring.

FFI is a central element in an evolving suite of interagency applications that provide field data capture and management tools. These applications include LANDFIRE, Fire

Regime Condition Class (FRCC), Fire Program Analysis (FPA), and Burn Severity Mapping (DNBR - Differenced Normalized Burn Ratio). A single software tool that can be used to monitor fire effects reduces the costs for software training, maintenance and support. Use of FEAT and FIREMON is increasing and this trend is expected to continue at a faster rate with the implementation of other applications such as LANDFIRE, FRCC, FPA, and Burn Severity Mapping. The Interagency Fuels Group will sponsor the FFI application with oversight provided by the Fire Ecology and Fuels Technical Transfer Working Group (chartered under the Fuels Group). FFI has already completed the initial submission of the OMB-300.

Project Scope

The components in the following diagram, Figure 1, form the scope for the integration of FIREMON and FEAT into FFI. FFI includes an anticipated system lifespan of ten years with estimated software revisions for technology updates (e.g. operating systems, enterprise architectures, etc.) required every three to five years.

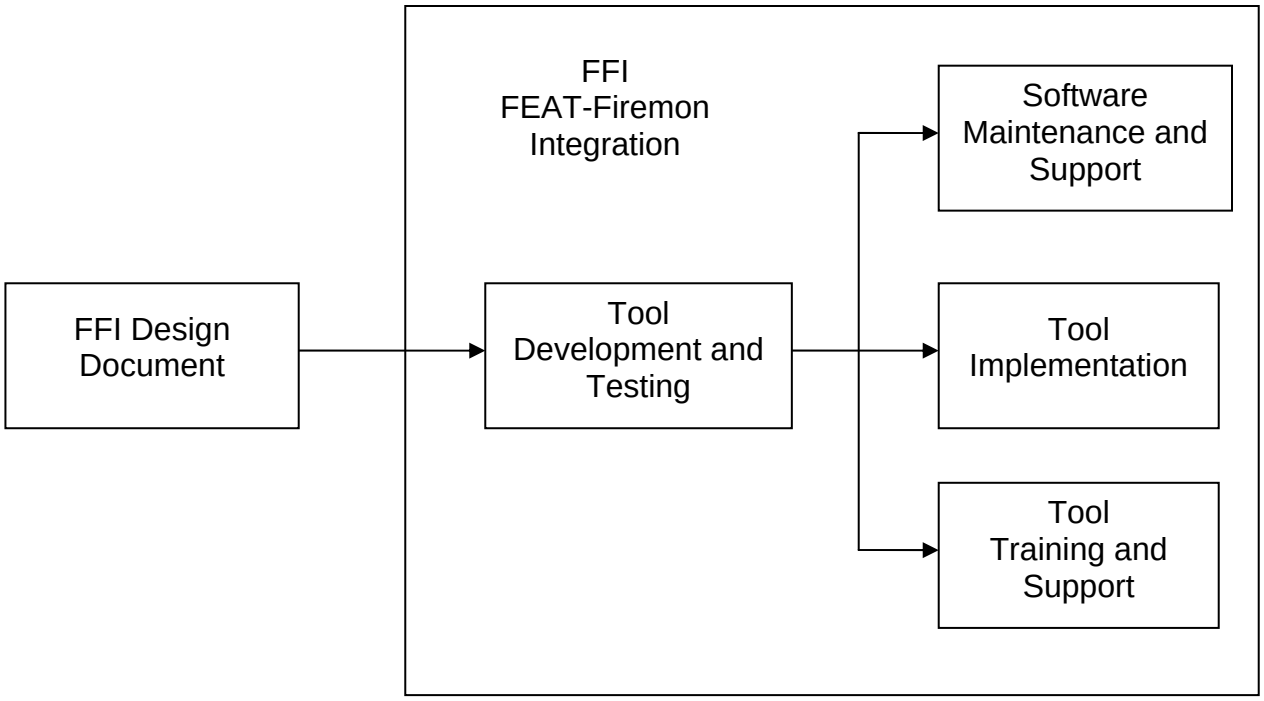


Figure 1 - FFI Project Components

Integrated Application Vision

The features of the FFI integrated tool are illustrated in Figure 2.

- FFI will integrate the existing features in FEAT and FIREMON to create an application with greater overall functionality and ease of use. The system includes all functionality and proposed upgrades contained in FEAT and FIREMON.
- FFI will exchange data with LANDFIRE, FRCC, and the Burn Severity (DNBR) Atlas.
- FFI has considered a Central Data Repository in the design, but will not consider implementation until a future date.

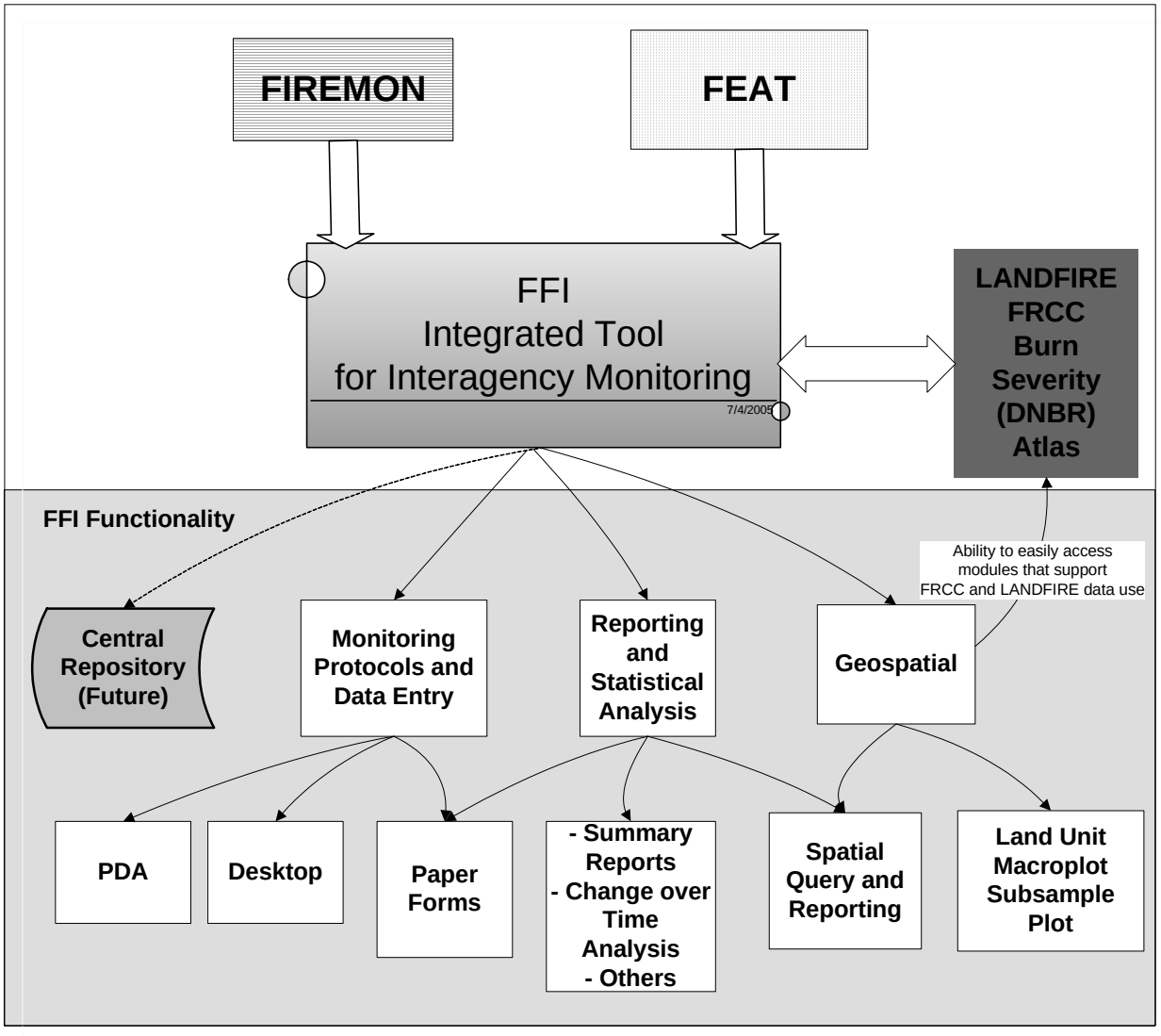


Figure 1 – FFI System Features

Business Requirements

The following diagrams represent the workflow for FEAT (Figure 3) and FIREMON (Figure 4). The FEAT workflow was developed during the FEAT business requirements analysis conducted by the National Park Service. The FIREMON workflow describes the Integrated Sampling Strategy that guides users through the FIREMON sample design and field sampling processes. The workflows provide a conceptual understanding of the steps involved in fire effects monitoring.

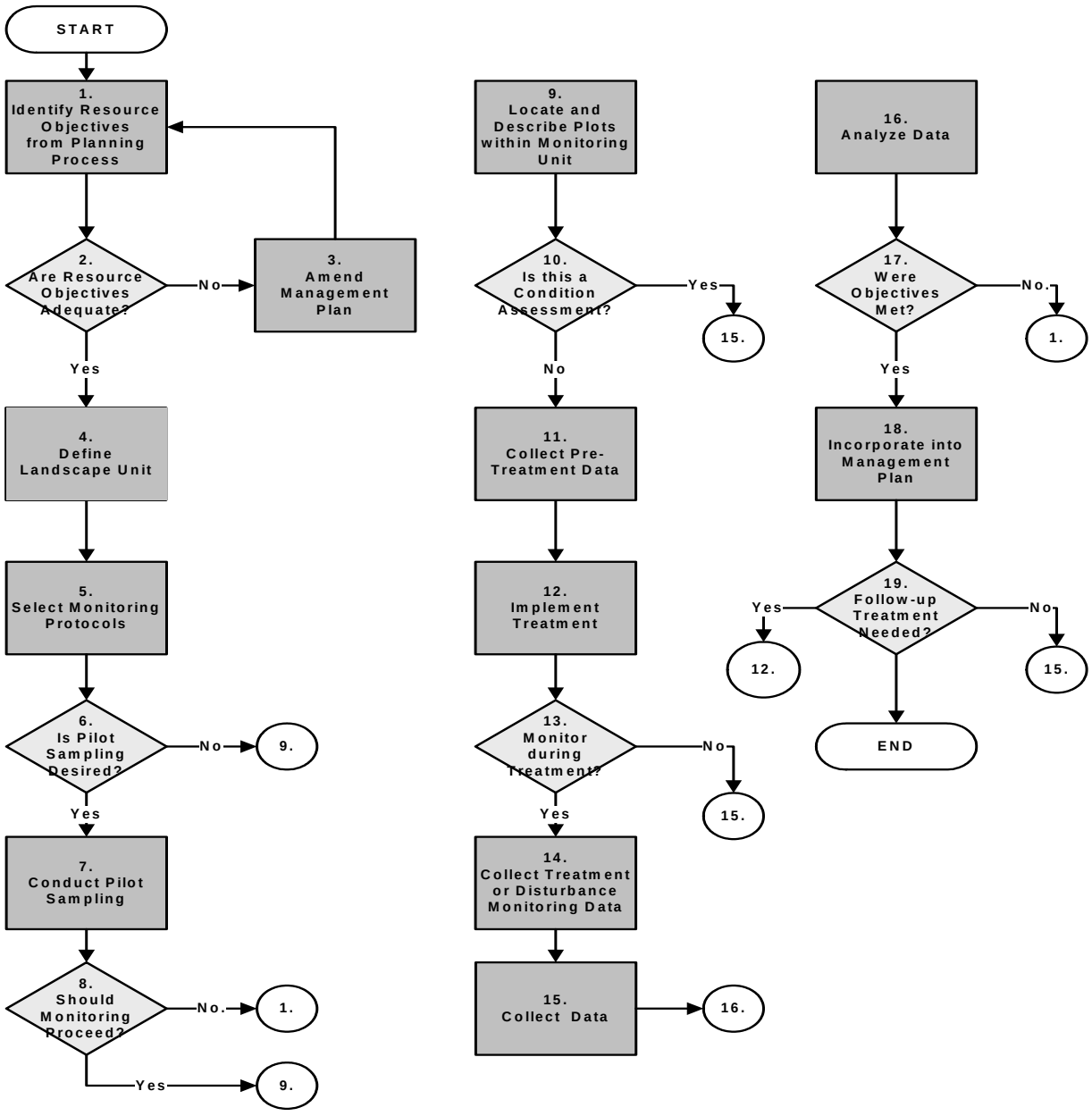


Figure 3 - FEAT Workflow

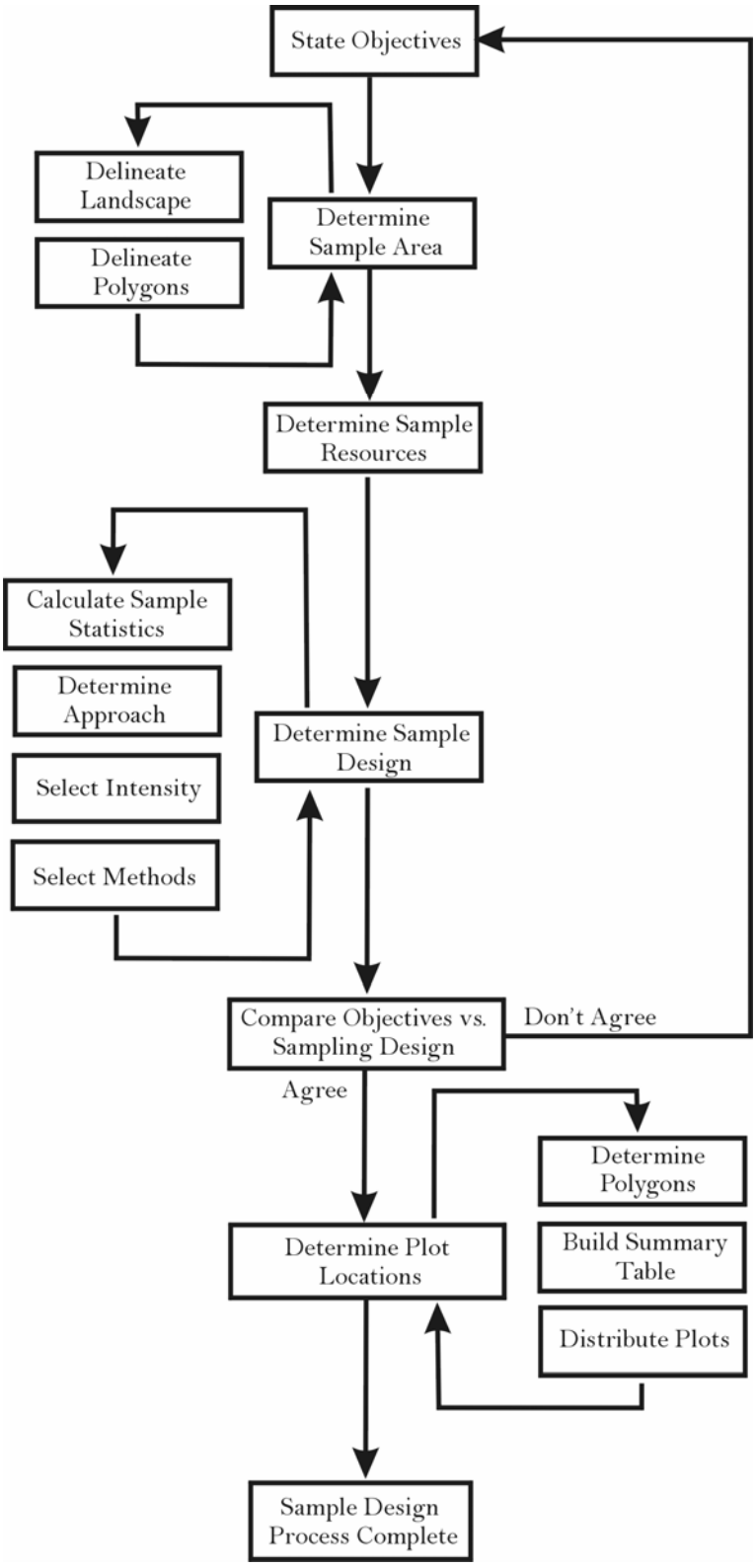


Figure 4 - FIREMON Workflow

Critical System Features

The following table includes a list of the features necessary for a successful FFI system as well as a description of each of these features.

Table 1 - Critical System Features

Feature	Description
Adapt to Agency IT Requirements	The FFI system will conform to stated IT policies and requirements for each federal agency so as to encourage the development of a broad user base. The FFI system will avoid complex solutions that would increase IT workload.
Data Exchange	For successful implementation, FFI must support the ability to import and export data from the many fire resource assessments, modeling, and monitoring tools. FFI Business Leads will identify priority systems that will require direct, system-specific, formatted file exchange with FFI. FFI will exchange data using common exchange formats with other non-priority systems.
Data Integrity and Accessibility	The integrity of monitoring data requires long-term information storage and accessibility within FFI. FFI monitoring data will be accessible to current as well as future tools. Sampling is a key component of any monitoring program. In FFI, sampling information will be carried forward with the monitoring data so that future users fully understand the context of any given set of monitoring data.
Ease of Use	FFI will support monitoring data collection and will require considerable interaction with program and field staff. Ease of use, especially in the field under adverse conditions, will impact the success of system acceptance. FFI users will range from experienced managers and researchers to seasonal and volunteer staff. The system supports field activities using common user access standards and a graphic user interface that shows clearly-defined user options.
Legacy FEAT and FIREMON Data Import	Since both FEAT and FIREMON are relatively new programs and users are not comfortable with continually changing systems, the transformation from the legacy systems to FFI will be straight forward, smooth, and as automated as possible.
Monitoring Program Management	Monitoring program design, planning, and operation.
Multi-user Access	Multiple users can access the FFI system at the same time.

Feature	Description
Protocol and Method Management	FFI success depends on management and use of protocols and methods using a Protocol/methods Builder. Users demand protocol modifications and flexible methods that meet specific, local conditions. The system must also monitor and maintain database integrity to provide consistent, understandable information. The Protocol/methods Builder will provide the database schema, forms, and metadata for new or modified protocols.
Robust Data Analysis	The environment for data analysis will address data accessibility, report generation, and a suite of standard analysis tools. FFI will aggregate data across projects and programs designed to accomplish national or regional aggregation of data. The database design and structure will support the aggregation of data.
Robust Technology Transfer	After business leads have completed initial work, agencies will have the bulk of the responsibility for technology transfers. The system developer will work closely with the agencies to build the infrastructure and knowledgebase to support FFI. Development support for technology transfer will include development of professional and technical documentation and preparation and deployment of an FFI training course.
Use of PDAs	Users have requested the use of PDAs structured for optimal use in the field.

FEAT System Heritage

The Fire Ecology Assessment Tool (FEAT) was developed for the National Park Service (NPS) Fire Ecology Program to identify fire use goals and objectives, assess ecological conditions, document burning conditions, record and evaluate fire behavior, verify completion of burn objectives, and follow long-term trends. In the early 1990's the Fire Ecology Program developed the Fire Monitoring Handbook and supporting FMH.exe software, a FoxPro application, which used standardized protocols for monitoring, analyzing and documenting fire use, behavior and effects. Advances in both information technology and fire monitoring methods led to the decision to develop FEAT as a follow-on application for FMH.

FEAT arose from the Fire Ecology Business Needs Analysis conducted from January through May of 2002. This analysis led to the establishment of a Project Core Team and involved regional program representatives, knowledge experts and stakeholders. The identified goals and objectives for FEAT include:

Goal: Provide a system that is adaptable to the changing business environment

Objectives:
- Provide the ability to easily add new monitoring protocols
- Provide the ability to monitor fire and non-fire treatments
- Provide the ability to incorporate and use wildland fire information
- Provide the ability to easily access policy and planning documents
- Provide the ability to easily access ecological and cultural information resources
- Provide the ability to use geospatial technology
- Support the tracking from management objectives to treatments
- Provide the ability to roll up data to the regional and national levels.

Goal: Provide a system that meets technical requirements for the fire ecology community

Objectives:
- Provide a system that is easy to use, maintain and administer
- Provide accurate information that is easy to access and export
- Standardize data to support the sharing of information
- Avoid data redundancy whenever possible
- Work efficiently in an open and varied technical environment
- Take advantage of the existing fire community and I&M technical environment.

Goal: Provide a system that is cost effective

Objectives:
- Provide a system that is cost effective to develop and implement
- Provide a system that makes the best use of staff time and resources
- Provide a system that is cost effective for the long term.

The development of the FEAT prototype began in late 2002 with the first fully operational version of FEAT, FEAT 1.2 released in April 2004. An updated version based on a modular architecture, FEAT 2.x, was released in March 2005. Additional modules of FEAT 2.x will be released during FY 2005.

The initial version of FEAT is based upon MS Access (2000) and includes a tight coupling to ArcMap 8.x desktop GIS, support of the FMH data collection protocols, support of additional protocols developed by the NPS, and PDA (Personal Digital Assistant) field data entry. FEAT 2.x is based upon Microsoft Desktop Engine (SQL Server) and a modular interface to ArcMap 9.x., PDA operations, and an interactive protocol and methods builder.

FIREMON System Heritage

Dr. Robert Keane, Research Ecologist at the USDA Forest Service Fire Sciences Laboratory in Missoula, Montana, developed the conceptual idea for FIREMON. He presented the initial FIREMON proposal to the Joint Fire Sciences Program in 2000 and received funding for the concept in 2001. Dr. Keane proposed a complete fire effects monitoring system that included a sampling strategy document to help managers develop sampling design, written sampling methods for the collection of data, a database to store the data, and summary and analysis routines to compile results.

The FIREMON system needed three primary attributes for successful implementation:

1. A written and presentation style that did not intimidate managers
2. A recognition of the limited resources available in most monitoring programs
3. Complete packaging that included sampling guidance, methods, database, and analysis

Users from development workshops provided the input that led to the incorporation of these primary attributes into the FIREMON system.

Lessons Learned from FEAT and FIREMON

Satisfying User Needs

FEAT and FIREMON offer similar lessons. Primarily, a successful fire effects monitoring system will incorporate users in the development process and will take agency guidance into account. FEAT included workshops with the NPS Fire Ecology staff throughout the Park Services System. The development of FIREMON included user input through workshops and other review that led to significant modification to FIREMON.

From FIREMON, FFI inherits a system designed with substantial user input, an existing set of methodologies, analysis tools, documentation and training materials, and the expertise used to develop these components. Much of the user input for FIREMON related to integrating existing, agency systems. For example, FIREMON incorporated Forest Service tree damage codes because Forest Service managers wanted to use FIREMON to build files needed to run the Forest Vegetation Simulator (FVS).

FIREMON weighted user needs more heavily than agency guidance. This caused problems toward the end of FIREMON development. For example, Forest Service users viewed the flexibility built into FIREMON as a positive enhancement. Upper-level Forest Service managers saw this same development as a lack of standardization. This led to concerns about FIREMON data quality. The BIA, BLM and FWS, however, have not voiced concern about FIREMON's lack of standardization. An example of standardized data collected using FIREMON are the custom protocols developed for the LANDFIRE project, which have been applied at thousands of sample plots in the West. The

FIREMON developers provide technical support by phone, electronic mail and Web-based discussion group.

The FEAT development team worked with an NPS Core Team during software development. The core team provided essential input for functional performance. They also identified and reviewed new field methods and protocols and supported beta testing for each FEAT release. The FEAT development team worked with NPS subject matter experts and conducted field testing of FEAT with NPS Fire Ecology Monitoring teams.

The FEAT development program includes several methods for communication with Park Service users. The program maintains a dial-up support/help line as well as an Internet based forum. In addition the NPS FEAT Core Team has served as the primary link between the development team and field users. A formal training curriculum for FEAT has been requested by system users.

Flexibility

FEAT includes the flexibility to allow users to modify existing protocols and develop entirely new protocols. This flexibility has increased the complexity of FEAT. While some users welcomed the increased capabilities, others criticized the increased complexity. The developers view user-defined protocols as essential tools for sampling ecological characteristics at the appropriate scale and intensity.

The integration of FEAT with the ESRI, ArcMap 8.3 software increased this complexity even further. ArcMap software installation and license management significantly complicated the software installation and operational overhead for FEAT. In order to reduce the complexity while maintaining flexibility, the second iteration of FEAT (FEAT 2.x) divided the system into several different modules to allow users to match system capabilities with monitoring tasks. FEAT currently has four modules:

- **FEAT-Desktop** supports an MSDE FEAT database, workstation data entry and review, and network-based multi-user access.
- **FEAT-Mobile** supports all desktop functions and adds database replication for disconnected operations and PDA-filed data capture and database updating.
- **FEAT-Spatial** supports FEAT GIS functions.
- **FEAT Builder** supports protocol and field method data management.

Initial users have responded positively to the module approach.

Information Technology and Security

IT operations and security concerns are essential to the FFI tool's success. Different agencies have different approaches to IT. As an agency, the Forest Service uses a centralized approach. The Forest Service developed the NRIS modules to facilitate the storage of all data into several corporate databases. Forest Service field managers prefer having access to their data on a local server or their desktops. This conflict has led to limited use of FIREMON in the Forest Service, where upper management requires field employees to use NRIS. The BIA likes FIREMON because it allows for storage of their proprietary data that cannot be stored on a remote server.

The widely distributed operations of the National Park Service affect the availability of IT services to FEAT users. It can be difficult for users to complete installations and install updates because of account authorizations. The most common FEAT platform is an independently operated portable computer. FEAT users will provide their own database administration and support. Database administration and support is a significant component of the FEAT dial-up support services.

Use of Personal Digital Assistant (PDA)

Field crews have requested a PDA field version of FIREMON. FEAT already supports PDA field data capture. Users have given mixed responses to the PDA version of FEAT. Issues include:

- FEAT 1 used ActiveSync to synchronize between the PDA and host DBMS. ActiveSync failed to maintain database synchronization and lost some data.
- It can be difficult to review data entered in the field compared to paper forms.
- PDA data entry can take longer that paper entry for some protocols.
- Reliable, non-destructible, data backup is necessary. FEAT uses SD or Compact Flash cards depending on the PDA model.
- Users need to learn PDA battery management and backup procedures.
- PDAs operate slowly.

Development Considerations

FFI will include architecture that enables the system to support new protocols and monitoring approaches developed and applied by field staff. FFI's architecture will also adapt to and support other monitoring programs in addition to fire effects monitoring. FFI will balance flexibility requirements with the need to provide an effective, secure, long-term data management environment for monitoring data. The FFI Design Team considered providing a web-based system. However, at present agencies do not have sufficient band-width to support a web-based application. A web-based version of FFI will be considered at the major upgrade interval of three to five years.

Development Environment

The FFI team evaluated MS .NET and Java as candidates for the development environment. The team's selection is MS .NET. Issues entering into this decision include:

- ESRI uses .NET rather than Java in the ArcMap environment, and we want to encourage users to take advantage of other ESRI functions in Arc Map. ArcMap is the standard for the GIS interface. The agencies use ESRI almost exclusively.
- The PDAs work with .NET but not Java. There are some third-party tools for Java on the PDAs but most of them are Java 1.2 and have limited capabilities and have at least a minimum licensing fee.
- .NET supports multiple languages, including VisualBasic and C++. The user interface will likely be developed in VB and the Analysis Module will likely be developed in C or C++ since many statistical algorithms are available in C.

A white paper on the .NET/Java comparison is included in the Appendix.

System Functionality

FFI will include all functionality contained in FEAT and FIREMON. The development of FFI will benefit from the substantial degree of reusability within the existing FEAT and FIREMON applications to reduce time and resources required to develop the software application.

Current development and planning experience indicates that the requirements for resource monitoring information extend beyond fire effects monitoring and that other monitoring programs and projects can use the architecture of FFI. The detail design and final implementation of FFI will allow for inclusion of other types of monitoring data within FFI.

FFI will use the considerable effort spent by FIREMON to solicit input from field-level management (direct users) through one or two development workshops and other user reviews and will concentrate development efforts on incorporating the recommendations and considerations of upper-level management. FFI will also incorporate input received

since the system release of FEAT and FIREMON. Additionally, FFI will improve the routines for producing the files needed to run other models. For example, FIREMON produces files for FVS at the plot level (one plot equals one stand). However, FVS can utilize files where multiple plots equal a stand. Based on user input, FFI will consider building input files for other models such as BehavePlus, FOFEM, Nexus, and other relevant applications.

Agency IT Standards

FFI will conform to the IT standards of the multiple agencies and departments using the system. The project business leads will develop agency-specific IT requirements for FFI and resolve any directly conflicting requirements. Agency requirements will likely vary, so implementation configurations of FFI may vary from agency to agency. For example one agency may support the installation of FFI on individual computer systems, while a different agency may wish to support FFI on a central server.

FFI system requirements are based on a number of common tools currently available within the participating agencies. MS Windows XP will provide the base operating system. Based on an initial evaluation, FFI will also run on MS Vista, the new MS operating system to be released in the second half of 2006.

Based on an evaluation of several candidate products, the FFI project team selected MSDE for the database management system (DBMS). The FFI tool will be based on the newly released version of MSDE, Microsoft SQL Express which is part of the SQL Server 2005. The team has determined to deploy the host DBMS at minimal cost for each installation and licensing overhead. FFI will also include a GIS module based on the ESRI ArcMap /ArcInfo suite of GIS tools.

System Security

FFI will conform to participating agency IT system security standards to address access to FFI by agency-authorized users. FFI will support four levels of internal data access or user level security:

- The **FFI administrator** can modify the database schema, create new database instances, import external data, and manage database users. Record locking will require FFI Administrator privileges.
- **FFI managers** can create protocols and methods.
- **FFI users** can read and write FFI data, queries, and reports, and export FFI data. FFI users cannot change the database schema.
- **FFI readers** will have read-only access to FFI. FFI readers can export FFI data.

In addition to user security, FFI will support record locking to lock individual records from further editing.

Platform and Database Considerations

FFI will provide a distributed deployment implementation for the installation of the application on a number of different user computer systems in different agencies. The FFI development team assumes a variable level of agency IT system support to users and a variable level of user technical knowledge. Users will need the tools and resources to support basic database management functions such as backup and restore, archiving, and adding and running provided procedures and scripts.

FFI will offer scalable resources, supporting a range of installations from a single user operation to a networked multiple-user configuration capable of supporting multiple database instances. The scalability is necessary to support the expected range of agency IT and user configurations. Some sites will consist of an FFI installation on a single portable computer with a single user while other installations support networks with many users. FFI will support database updates and merging from disconnected database instances with a minimum of overhead.

FFI will support the transfer of system-compliant FEAT (version 2.3 and above) and FIREMON legacy data. This one-time transfer will move existing data into FFI so users can begin using the new database and system features.

FFI will support data migration from within a single, common database to multiple, participating FFI databases. For example, it will be possible to combine data into a single database instance, such as a regional database or data from a number of site-specific FFI databases.

Operational Lifespan

Because the monitoring data that FFI supports has long-term value to agency monitoring programs, FFI plans for an operational lifespan of ten years with a major upgrade or modification approximately three to five years after initial release. The design of FFI will anticipate the forward-looking, long-term maintenance of monitoring data including providing a conceptual basis for transferring FFI data to a new generation replacement system and the need to restore archive data into a new system.

Data Exchange

Many analytical tools use monitoring data. For example, the LANDFIRE project uses FIREMON to collect data; the DNBR Atlas uses both FIREMON and FEAT to collect Composite Burn Index (CBI) data. FFI will use XML as the standard for data exchange between FFI and other applications. XML will also be used to import and export species lists as well as support database–to-database information exchange, such as updating of new protocols and methods across a number of FFI instances. FFI will also support .DBF files as a secondary format for data exchange.

Applications that may use or exchange data with FFI include:

- LANDFIRE
- FRCC
- FVS
- Burn severity
- Geospatial DNBR Atlases
- FPA
- FOFEM
- NEXUS
- BehavePlus

Some of these applications may require an application-specific file transfer capability with FFI.

Use of PDAs

FFI will support collection of field data using PDAs and possibly other mobile devices using the Microsoft Pocket PC operating systems. The initial release will not support other PDA operating systems such as Palm and tablet computer systems. FFI will allow for the use of multiple PDAs within the same sample site. FFI will also support a full set of paper-based forms for data collection and keyboard/workstation data entry. The forms will be provided with the system as PDF files, so that users can print specific forms as they need them.

Functional Requirements

Monitoring Program Management

Monitoring program management includes monitoring program design, planning, and operations. FFI will support the documentation of monitoring objectives and the specification of monitoring field activities. Typical monitoring program management information includes:

- Management objectives
- Monitoring objectives
- Planned treatments
- Physical description of the monitoring unit or subject area of interest
- Objective variables to be measured
- Biological description of the monitoring unit or subject
- General sampling design including acceptance and rejection criteria
- Field team instructions
- Operational schedules.

The definition of area of interest can include GIS-based spatial analysis results, administrative units, or ad hoc, user-specified areas. FFI will support the storage and reporting of area of interest specification criteria as well as spatial data defining the physical extent of the area of interest.

A monitoring manager or program lead will develop program information used to provide guidance to other monitoring program participants and document program activities for future reference.

The FFI metadata table will store all of the information used and developed while designing a monitoring program, as well as an explanation of how the data was collected, to record the context of the data for future reference.

Protocols and Method Management

FFI will support flexibility in the specification and implementation of different sampling methods and protocols. Methods include the field procedures and data elements collected at sampling sites. A protocol defines the methods applied at each sampling site. Methods and protocols may change as a monitoring program progresses.

A monitoring program manager will be able to add new methods to the FFI Method Library. A program manager will be able to specify different field protocols. Methods and protocols will have links to bibliographic references maintained by FFI.

FFI will support all protocols and methods supported by FEAT and FIREMON. In most cases it will be possible to merge similar or identical FEAT and FIREMON protocols. In a few cases separate FEAT and FIREMON protocols will be required.

Sampling Design and Execution

Sampling design and execution include the identification of sample sites using statistical or selective sampling procedures, normally defined by the monitoring project manager. The manager will use the FFI Integrated Sampling Strategy to assist in selecting a sampling methodology such as stratified random sampling, defining the criteria of each stratum, the extent of each strata, the number of samples, the sampling method (random), and possibly the minimum distance between samples. GIS tools can support the location of sample sites. The sampling functions will locate sample units based upon specified criteria and a selected sampling scheme. Recorded sample information will include the sampling scheme linked with the monitoring program management information and the sample location. FFI will generate a list of possible sample sites for review using GIS tools, such as aerial photography, as well as initial field visits. Additionally, FFI will include means for developing field-based sample acceptance/rejection criteria, such as specified minimum percent of forest cover, and tracking the acceptance or rejection of each sample site.

Data Capture

Most FFI users will be primarily concerned with field data capture. Supported data capture techniques will include the use of FFI-generated field forms and workstation data entry, and the use of Pocket PC-based PDAs. Because field data capture is the most used FFI function, the quality of the user interface, paper forms, data entry screens, and PDA operations is important.

Computer entry of data recorded on paper forms will be accomplished using custom and/or default data entry screens. FFI will have data entry screens similar in appearance to paper forms for each field sampling method as well as default screens for any new or added methods.

Data recorded on PDAs in the field will be transferred from the PDA to the FFI database through a data transfer utility. A single sampling site can use more than one PDA. As part of the data transfer function the user may provide information to resolve data conflicts such as redundant records. FFI software tools will support the transfer of data from the PDA to FFI database.

Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) addresses those procedures and tools used to ensure the accurate collection, recording, and maintenance of monitoring data. Operational tools will include:

- Range validation such as minimum and maximum values for workstation and PDA data entry.
- Use of specific code lists to limit data entry choices to specified values or codes. The system will support the modification and addition of code values over time.
- Use of interactive displays to review data entry. Screen displays that mimic the paper field data forms provide one example.
- The preparation of QA/QC Reports that screen for and report errors or inconsistencies, including reporting of cross-field errors.
- The review of field data forms for data validation and printing of a hardcopy backup.
- The ability to access and edit data to correct errors. Associated with data editing is the ability to track dates when a record is accepted and locked. Only administrative (database) users will be able to lock or unlock records. When a record is locked the user ID and date will be recorded.
- Mass updates such as global replacement of a species code.

Data Analysis

Analysis functions will include standard analyses for the specified methods listed in the Data Analysis section. FFI will also support the ability to export data to other analytical tools such as spreadsheets and statistical analysis software based upon common export formats.

Reporting

Reporting functions will include tabular and spatial reports. Tabular reporting will be based on the production of standard reports as well as a generalized ad hoc report generator where the user can specify variables and generate a basic report. Tabular reports will contain information by individual sample sites and groups of sites. Spatial reports will address basic monitoring area of interest maps and show sample site locations, site by date sampled, sites by sample results, and sites by trends.

Query

Both predefined and ad hoc query functions will enable the user to define criteria for monitoring data retrieval and reports. FFI will store an ad hoc query for future reuse and spatial queries using GIS tools. Spatial queries will include query by layer or overlay, by adjacency or buffer, and selective point-and-click or group queries.

As part of the query tools, FFI will support an FFI-to-FFI transfer function that will select specified sample sites and monitoring events and prepare and export files for transfer to another FFI site or database.

Common Data Exchange

Exchanging data with other systems represents an important FFI function. Interactive tools will allow users to exchange data with other systems. The selection criteria may include site variables or GIS tools to spatially select sites. Users will retrieve selected data using a query and then transform it into the appropriate export format.

Data exchange will address both tabular and spatial data and use XML to exchange data between FFI and other systems. FFI will integrate with many different software tools using a minimum of programming and development overhead. FFI will likely integrate or exchange data with the following systems:

- LANDFIRE
- FRCC
- FVS
- Burn Severity
- Geospatial DNBR Atlases
- FPA
- FOFEM
- NEXUS
- BehavePlus
- FuelCalc.

FFI Business Leads will make the final selection of the supported file integration applications.

FFI will develop spreadsheet and Access database templates to facilitate the import of external data. The exchange of spatial data between FFI and other GIS systems will be based upon shapefiles, ESRI export files, and raster/grid data products.

An FFI-to-FFI import and export tool will support the transfer of selected data between different FFI databases.

Species Data Management

Species Data Management is a major component of all monitoring data. FFI still needs to determine a common source for the species list. The most likely source is the NRCS Plants Database (plants.usda.gov). An FFI user will be able to build a local, project specific, species list by drawing from the master list, and will be able to assign a local code for species data entry. Species list management will include local management of species lifeform, lifecycle, invasiveness, and sensitivity classifications.

FFI can import and export species lists and protocols using XML.

System Administration

FFI will provide system administration tools to assist with basic database management functions. Support functions will include easy, user-directed database backup and restore functions that will allow for the restoration of a backup on a different database server.

FFI will support the administration of user access to the database including user identification and password assignment as well as four levels of user access privileges assignments. Privileges levels include: administrator, manager, general user, and read-only user.

Backup and Restore

FFI database administration and support will include database backup and restore operations that can be accessed as FFI functions or tools. The backup will support the automated naming and storage of backup files with the ability of the user to change file names and storage locations. Restore functions will also support automated file retrieval, most recent backup file, as well as user specified browsing to specific files. The backup and restore will support the complete restoration of an FFI database on a different database server. The backup file format and structure will allow for off-system and off-site storage.

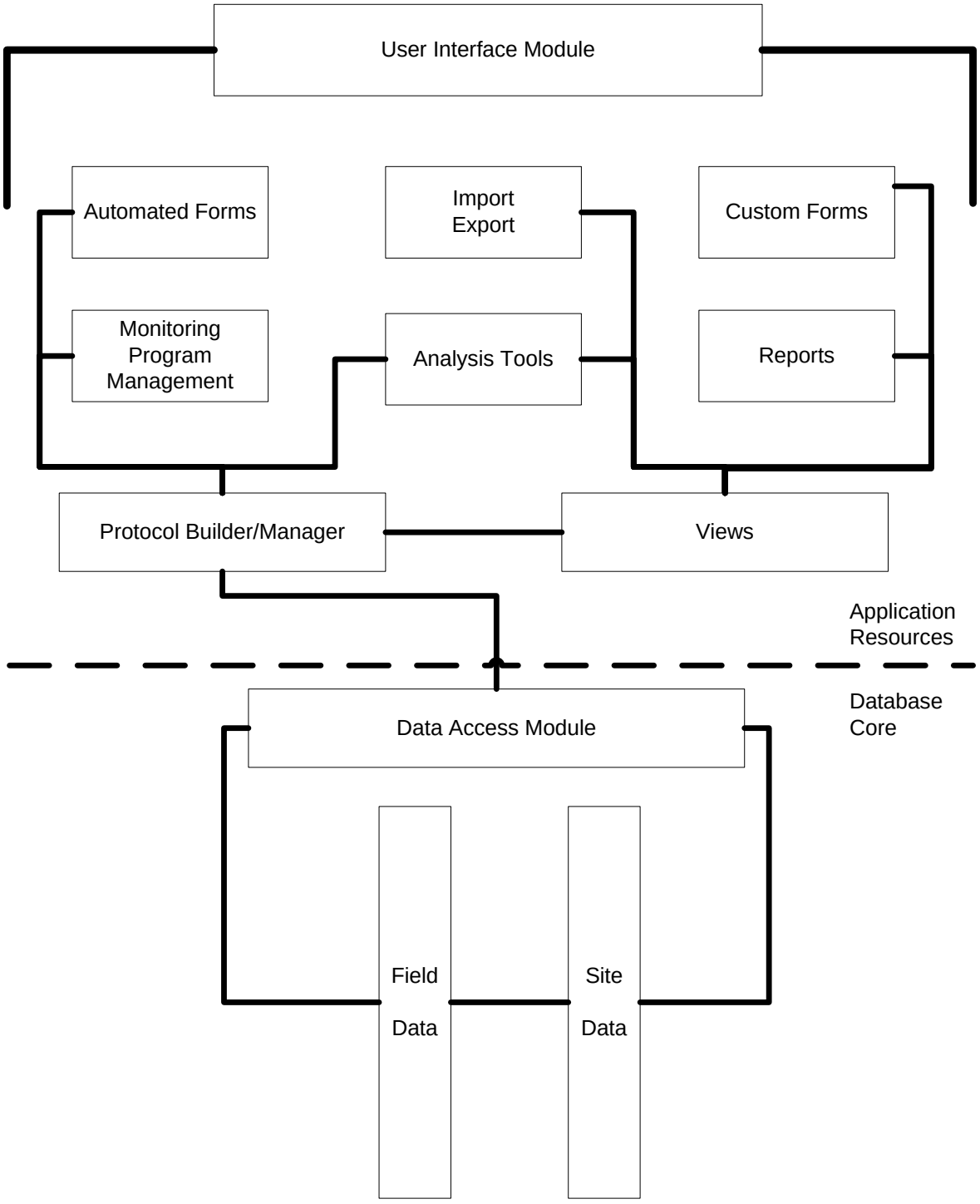
Technical Architecture

Core System Architecture

Figure 5 is a block diagram representation of the current approach for the FFI Core System architecture. The Core System will consist of a database engine component, the database core, which will be accessed by the FFI application components via a standardized data access module. The core database structure will be highly normalized using a minimum number of tables to store the monitoring data. Keys and indexes to the protocol and method data, including site conditions, will be integrated with the Protocol Manager/Builder. The Protocol Manager/Builder provides two functions: the user-perspective management and documentation of field methods and protocols, and the system management of the database keys and indices. The protocol manager will also provide some support to the data analysis module. The typical user will have minimum contact or interaction with the core database component.

The primary user access to the system will be supported by the View Module, which will be used to produce denormalized tables, reports, and data sets. These user data sets will be in a format that is familiar to an experienced field monitor and will be compatible for use in the analysis module, generation of reports, and export to other generic systems, such as statistic packages and spreadsheets. The View module will support reporting, analysis, custom data entry forms, and data importing and exporting. In addition to supporting the database keys and indices, the Protocol Manager/Builder will provide monitoring program management tools as well as automated generation of data entry forms. The Protocol Manager/Builder enables the user to define and add new field methods and protocols to FFI without having to perform any custom programming. Users will be able to export in XML format.

Figure 5
FFI Core System
Conceptual Architecture



Data Collection

FFI data collection tools support the capture and entry of field sampling data. All the standard FEAT and FIREMON methods will provide sampling methods that describe procedures for collecting data, including standard hardcopy field forms. The system can conduct plot data entry from a desktop computer using paper field forms or through the use of PDA synchronization. Users may also design additional sampling methods for their specific sampling requirements. With the Protocol/Method Builder, users can generate basic paper field forms, desktop data entry forms, and/or PDA data entry forms for user-defined sampling methods.

Update of Species Lists

FFI will support the maintenance of species lists within a single FFI database instance. In FFI, users will be prompted from a dropdown list of species codes when entering data into a *species name* field of the FFI database. These dropdown lists provide an ease of data entry, limit data entry errors, and provide for consistent plant species coding. Loading large species lists (for example, there are 82,000+ species codes in the NRCS plants database) into the dropdown lists is cumbersome. Users will populate FFI dropdown lists with only the species codes that occur in their projects. This will be accomplished using an FFI database utility where users select species from a master list, define a plant code and life form for species that occur in their projects. Optionally, a user may also define invasiveness and sensitivity status for a specific species.

Since the name for a plant species may change over time, the plants database that FFI uses as a master cannot include only a static compilation. FFI will include the most recent plants list with each new release and provide a utility or instructions to allow users to load new versions of the master list as they become available. This system will include tools for managing species lists over time. FFI can import and export species lists and protocols using XML.

Spatial Functionality

FFI will organize the spatial/GIS functions into a single module. The module approach limits the number of ESRI software installations needed to support FFI since not all users will want to use GIS functions. The GIS module will be based upon the ESRI ArcMap 9.1 software and spatial analysis extensions. Business Leads may also evaluate other spatial software engines such as ESRI GIS engine, ArcView 3, and open source alternatives. All GIS alternatives will include support of raster/grid data processing.

The spatial module will be tightly coupled with the FFI database. Data input, output, and modifications will occur within the base FFI database tables, eliminating the need for any interface tables.

PDAs

PDAs will use the Windows Pocket PC operating system. While no specific PDA manufacturer has been identified, PDA compatibility will be assured by the operating system specification. FEAT 2 uses SQLCE for the PDA database system. PDAs will support external database backup (such as an SD or Compact Flash card) with the ability to restore the data backup on a different PDA and database instance. The PDA will interface easily and simply with host DBMS. FEAT 2 uses XML data transfer between SQLCE on the PDA and the host MSDE database. Data exchange with the host database will be reliable.

FFI will support multiple PDA synchronization with the same host database and the operation of multiple PDAs at the same sample plot.

Data Analysis

FFI will include the analysis tools package currently in FIREMON. This tool includes data summarization for a number of components, as defined in the following table:

Table 2 - Data Summarization Components

Method	Attribute	Attribute	Units (E)	Units (M)
Plot description	Tree cover		Percent	Percent
Plot description	Seedling cover		Percent	Percent
Plot description	Sampling cover		Percent	Percent
Plot description	Pole cover		Percent	Percent

Method	Attribute	Attribute	Units (E)	Units (M)
Plot description	Medium tree cover		Percent	Percent
Plot description	Large tree cover		Percent	Percent
Plot description	Very lg. tree cover		Percent	Percent
Plot description	Shrub cover		Percent	Percent
Plot description	Low shrub cover		Percent	Percent
Plot description	Medium shrub cover		Percent	Percent
Plot description	Tall shrub cover		Percent	Percent
Plot description	Graminoid cover		Percent	Percent
Plot description	Forb cover		Percent	Percent
Plot description	Fern cover		Percent	Percent
Plot description	Moss cover		Percent	Percent
Cover/frequency	Cover	By individual species or all species	Percent	Percent
Cover/frequency	Height	By individual species or all species	Percent	Percent
Cover/frequency	Nested-rooted-freq. subplot 1	By individual species or all species	Percent	Percent
Cover/frequency	Nested-rooted-freq. subplot 2	By individual species or all species	Percent	Percent
Cover/frequency	Nested-rooted-freq. subplot 3	By individual species or all species	Percent	Percent
Cover/frequency	Nested-rooted-freq. subplot 4	By individual species or all species	Percent	Percent
Density - Belt	Count	By species, status and size class or item	Count/ transect	Count/ transect
Density - Belt	Area	By species, status and size class or item	Count/ac	Count/ha
Density - Belt	Height	By species, status and size class or item	Feet	Meters
Density - Quadrat	Count	By species, status and size class or item	Count/ transect	Count/ transect
Density - Quadrat	Area	By species, status and size class or item	Count/ac	Count/ha
Density - Quadrat	Height	By species, status and size class or item	Feet	Meters
Surface fuels	1-hr		Tons/ac	Kg/sq.m

Method	Attribute	Attribute	Units (E)	Units (M)
Surface fuels	10–hr		Tons/ac	Kg/sq.m
Surface fuels	100-hr		Tons/ac	Kg/sq.m
Surface fuels	1-100-hr		Tons/ac	Kg/sq.m
Surface fuels	1-1000-hr		Tons/ac	Kg/sq.m
Surface fuels	FWD		Tons/ac	Kg/sq.m
Surface fuels	CWD		Tons/ac	Kg/sq.m
Surface fuels	Duff depth		Tons/ac	Kg/sq.m
Surface fuels	Litter depth		Tons/ac	Kg/sq.m
Surface fuels	Duff + litter depth		Tons/ac	Kg/sq.m
Surface fuels	Duff biomass		Tons/ac	Kg/sq.m
Surface fuels	Litter biomass		Tons/ac	Kg/sq.m
Surface fuels	Shrub biomass	Live and dead	Tons/ac	Kg/sq.m
Surface fuels	Herb biomass	Live and dead	Tons/ac	Kg/sq.m
Surface fuels	Shrub cover	Live and dead	Tons/ac	Kg/sq.m
Surface fuels	Herb cover	Live and dead	Tons/ac	Kg/sq.m
Tree data	Mature count	Live, dead; individual or all species	Trees/ac	Trees/ha
Tree data	Mature tree basal area	Live, dead; individual or all species	Sq. ft/ac	Sq.m/ha
Tree data	Mature tree dbh	Live, dead; individual or all species	Inches	Centimeter
Tree data	Mature tree height	Live, dead; individual or all species	Feet	Meters
Tree data	Mature live crown percent	Live, dead; individual or all species	Percent	Percent
Tree data	Sapling count	Live, dead; individual or all species	Trees/ac	Trees/ha
Tree data	Sapling height	Live, dead; individual or all species	Feet	Meters
Tree data	Sapling live crown percent	Live, dead; individual or all species	Percent	Percent
Tree data	Seedling count	Live, dead; individual or all species	Trees/ac	Trees/ha
Line intercept	Cover	By species, status and size class	Percent	Percent

Method	Attribute	Attribute	Units (E)	Units (M)
Line intercept	Height	By species, status and size class	Percent	Percent
Point intercept - transects	Cover	By species and status or item	Percent	Percent
Point intercept - transects	Height	By species and status or item	Percent	Percent
Point intercept - frames	Cover	By species and status or item	Percent	Percent
Point intercept - frames	Height	By species and status or item	Percent	Percent
Ocular macroplot	Cover	By species, status and size class or item	Percent	Percent
Ocular macroplot	Height	By species, status and size class or item	Percent	Percent

Added FFI Analysis Functionality

FFI will add the following analysis functions that do not currently exist in either FEAT or FIREMON:

- Tree summarization tool (to estimate attributes in user determined classes). BA and TPA by species and DBH.
- Export files for One-sample t-tests, chi-square and other non-parametric tests added to the analysis tools utility.
- Integrated Sampling Strategy modifications to describe how/when to use new tests (and the associated methods) or reference Elzinga.
- Statistical review of new statistical tests.
- Improvements to the FVS-FFE output files (multiple plots per stand, updated tree species codes, and any new coding as required by FVS).
- Output files for fire-related modeling and testing. Possible examples include FCCS, (Fuel Characterization Classification System), FOFEM, Nexus, BehavePlus, and FuelCalc.

Import/Export

Legacy Data Migration

FFI will provide routines to import legacy data from the most recent release of FEAT and FIREMON. A standard set of import functions will take XML or DBF files generated from FEAT or FIREMON and map them to the database tables and fields within the FFI database. FFI will also provide data migration support to FEAT and FIREMON users who have problems migrating to the new FFI database. Since FIREMON users might possibly modify their data tables and/or codes, some minor data formatting issues might need resolution before a successful data migration can occur.

A high-level database administrator will be available to help format and migrate legacy data and facilitate the data migration process. FFI will provide this support for users having difficulty migrating legacy FEAT or FIREMON data, but will NOT perform QA/QC on poor quality data or migrate data from formats other than FEAT or FIREMON.

Import/Export of Plot Data and Local Species Lists

FFI will allow users to import and export all plot data and local species lists via XML or DBF files. For example, FIREMON currently uses XML files to import and export plot data and local species lists. FFI will generate a portable file for either all or a subset of tables and/or a local species list to import data into another FFI database. This will facilitate data sharing between FFI users within the current FFI database structure.

Import / Export Protocols

FFI will support importing and exporting new protocols developed with the Protocol/Method Builder using XML.

Export of Data to Statistical Analysis and Other Modeling Tools

FFI will generate XML or DBF files to export data to other statistical analysis software and modeling tools. Export operations will use a query builder to generate a table of specific fields from one or more FFI database tables. The resulting table will contain data of interest to users that requires statistical analysis beyond the basic capabilities of the FFI analysis software. FFI will also support the export of spatial data in industry standard shapefile or raster/grid formats.

Export of Data to FVS-FFE

FFI will allow users to generate input files for the Forest Vegetation Simulator with Fire and Fuels Extension (FVS-FFE) for temporal modeling of stand dynamics and fire effects. Currently, FIREMON generates FVS-FFE input files for one FIREMON plot having tree data and fuels data. FFI will also allow users to select a group of plots, calculate average tree data and fuel loading values, and then generate the required input files for FVS-FFE. This allows users to calculate a stand average from several plots and then use this stand as input into the FVS-FFE model.

Export of Data to LANDFIRE Reference Database

FFI will include features to import LANDFIRE Reference Data and to export FFI data in a format compatible with the LANDFIRE Reference Database (LFRDB). LANDFIRE reference data helps model and map vegetation and fuels. The LFRDB is currently using the FIREMON database structure and the LANDFIRE field crews are currently collecting reference data using the LANDFIRE Plot Description (PD), Species Composition (SC), and Fuel Load (FL) sampling methods. These sampling methods will be included in FFI and the import/export functions will crosswalk data between the FFI database structure and the LFRDB database structure.

Other Import/Export Requirements

FFI can support many fire resource monitoring, assessment, and modeling tools through XML data transfer. The FFI Business Leads will evaluate the different systems and identify those priority systems that require a direct, system-specific formatted file exchange with FFI. FFI can support exchange of data with other non-priority systems using XML and DBF formats. Systems FFI will support:

- Import LANDFIRE spatial data layers for pre and post plot stratification and data summaries in shapefile or raster/grid formats.
- Import Fire Regime Condition Class (FRCC) spatial data from the FRCC mapping tool in shapefile or raster/grid formats.
- Import Burn Severity data layers in raster/grid format.
- Explore linkages between FFI and FRCC / FRCC mapping tool, Fire Program Analysis (FPA), fire behavior and fire effects models, Fire Research and Managements Exchange System (FRAMES), and FuelCalc.
- Export data for First Order Fire Effects (FOFEM) (e.g., fuel loadings, shrub and herb loadings, and tree data).

Protocol/Method Builder

FFI will configure the Protocol/Method Builder (P/MB) as a separate module to define data attributes for a specific method, including:

- Data type
- Size/Format
- Default values
- Minimum, maximum values
- Attribute name
- Dependencies
- Data codes
- Associated calculations
- Form presentation sequence
- Requirement status
- Attribute descriptive metadata information.

The P/MB will generate database schema for each specific method included in FFI as well as desktop and PDA data entry forms. The automated generation of the schema and data entry forms enables users to add new methods to FFI without any programming support.

With P/MB, a user may combine a group of methods to form a protocol from a list of information collected at each sample site. The protocol also links to metadata that identifies published reports and papers that document the methods. Protocol documentation can include utilized field procedures, collected data elements, and analysis procedures. The P/MB also references the agency or program responsible for the development and maintenance of the protocol.

Template Builder

Each method can have an associated sample configuration template. The sample template defines the physical layout of sample sites for use with a specific method. Typically a sample site may include one or more transects sampled with belts, frames, or points. The template builder will support single and composite sample site configurations including:

- Circles, including nested samples
- Transects with increments and with points
- Nested transects
- Belts including with subbelts
- Frames with transects or with quadrats
- Points and photo points.

In addition to sample type, the template builder will provide sample dimension information and support the mapping of sample arrangements using the GIS model. Several methods may use a single template. The template builder will support the creation of a new template, the editing of existing templates, and the database storage and documentation of templates.

Reporting

FFI will generate two types of data summary reports:

1. Reports that summarize data for each plot.
2. Reports that summarize data for groups of plots.

Examples of data summaries include downed fuel loadings, tree density and basal area, and plant species cover, frequency, density, or biomass. Data summary reports for each plot require summarizing data collected on the macroplot (for example, tree density and basal area), summarizing data from samples within the macroplot (for example, fuel counts on transects, cover estimates within quadrats), or simply reporting selected attributes recorded for the macroplot (for example, CBI values, cover estimates).

FFI users will be able to select all plots or a subset of plots to generate data summary reports for each plot (for example, fuel loadings, tree density, and plant species cover). FFI will include the standard set of reports currently included in FIREMON and FEAT that summarize data for each plot. Summarized data is available for individual plots or groups of plots. In addition, users will be able to generate the data summarization reports for groups of plots. Plots may be stratified through tabular or spatial queries. FFI's new group summarization reports will calculate median, mean, minimum, maximum, and standard deviation for each group of plots. The attributes summarized are shown in Table 2 by plot groupings for the same attributes as the plot summary reports. Data summary reports may be exported in CSV format. FFI will also provide the ability to cut and paste summary reports into other documents and to generate PDF files.

FFI will support an ad hoc query tool to enable users to develop their own queries and save them for future use. The query tool will also support the execution of save queries as well as exporting and importing saved queries. The query builder will generate formatted data tables and support the export of spreadsheets as Excel or CSV files providing generic data interface to other systems.

Sampling Design

The FFI sampling design tools will use integrated GIS utilities and will include the ability to conduct sampling if the GIS tools are not present. FFI will support both the NPS FMH (FEAT) sampling design based on the concept of the monitoring unit or monitoring type and FIREMON's Integrated Sampling Strategy.

The sampling tool will support statistical and selective sampling design for locating and selecting sample plots. The GIS component will enable the user to define the spatial extent of a sampling domain or stratum, using a number of common geo-processing tools, including:

- Feature selection
- Composite overlay
- Buffer
- Range
- Administrative boundaries
- Ad hoc boundaries

A number of different sampling methods will be supported with automated tools, including:

- Random sampling
- Stratified random sampling, with minimum distance
- Cluster sampling
- Systematic sampling
- Selective sampling

The FFI sampling tool will maintain the sampling history, rationale, and sample method for each sampling domain and selected sample site. The sampling tool will support the mapping of sampling domains, strata, and sample site locations. The tool will include a drill down summary of GIS data for a sample site. Sample site location mapping will use other available GIS layers and images for locating and accessing sample sites.

The sampling tool will also maintain information about rejected sample sites including site location, sampling history, and reason for rejection.

GIS

The FFI GIS tools will conform to existing agency GIS system standards currently based on the ESRI ArcInfo GIS systems. The FFI GIS will be a standalone module that will use the ArcMap environment for spatial analysis while providing a seamless link to the FFI database and user tools. The GIS operation of FFI will require the Spatial Analyst Extension to ArcMap. GIS operations will be workstation based. There are no plans for integration of PDA-based GIS tools in FFI.

The FFI system will not include licensing and distribution of the GIS software. Users must obtain the GIS software and appropriate keycodes from their GIS coordinator or IT departments.

The FFI GIS will support automated inclusion and processing tools for essential common data sets such as select LANDFIRE layers, FRCC layers, DNBR layers, digital terrain models, management boundaries, and public land survey identified during the detailed design of FFI. The design base assumes that a GIS module user will have a moderate understanding of GIS principles and operations. The GIS will support all common spatial dataset types including: Line, Point, Polygons, Grids, Images, Digital Raster Graphics (DRGs), Aerial photography Digital Ortho Quads (DOQs), and Satellite Imagery.

The GIS will support the reporting and mapping of sample sites by location, sampling events, and sampling results. The GIS will also support the reporting and mapping of sites by spatial query including map unit overlay, buffer, and ad hoc, user drawn map areas. The GIS based queries will link to FFI report functions including ad hoc reporting. GIS based queries will also link to the FFI analysis functions to select GIS sample sites for analysis.

The GIS will also support the mapping of individual method samples, transects, and quadrants for mapping the configuration or layout of a sample site protocol.

Database Engine

The FFI team evaluated proprietary and open-source software to select a database engine. Open-source software is potentially more robust, easier to maintain, requires less overhead, and costs less. Proprietary software has user familiarity and some agencies already have licenses for several products (e.g., Access, Oracle).

During an initial screening (see Table 3), FFI system developers tested several options. MySQL was explored as an open-source database, and SQL Server, Access, and ORACLE were reviewed as options for proprietary software. Another possibility considered was to build the FFI application so it is compatible with multiple database engines. Another factor in the evaluation was the possibility of restrictions due to agency licensing constraints that would restrict the use of open-source software.

The developers tested the products, compared the results, and reported back to agency sponsors, who decided on the final product. The two recommended packages were MySQL and MSDE. MSDE, which is a trimmed-down SQL server, was selected for use as the database engine. Key reasons for this decision are:

- No licensing required.
- Ongoing Microsoft support.
- Broad user base.
- Acceptable response time.
- Option remains open for later move to MySQL.

Table 3 - Database Options

Database Option	Comments
MySQL	MySQL is a very popular and widely used open source database. • **Advantages:** Lower costs to users, robust database, use in many web and business applications, potentially easier to maintain with greater longevity than commercial products that may become outdated as newer versions are released. MySQL runs on multiple operation systems and supports XML file transfer well. • **Disadvantages:** A lack of familiarity with this product by agency personnel. The performance of accessing a MySQL database through a Microsoft Access database will be explored. (Use of Access would allow users to interact with their data within the familiar framework of Access.) MySQL does not run on PDAs, so a different PDA engine or custom application will be necessary.
Microsoft Desktop Engine (selected)	The Microsoft Desktop Engine (MSDE 2000) is the desktop environment for SQL Server. • **Advantages:** MSDE may be distributed free of charge and users may open a SQL server database within an Access project. This allows users to interact with their data using familiar methods such as the Access query design window. MSDE is a true client-server database running well on networked systems providing good multi-user support. There is a PDA version, SQLCE. • **Disadvantages:** The SQL server does not work with personal firewalls and since it is a client/server application, connection and disconnection of the master database from the network will be supported by the FFI application. Frequent software updates and enforced obsolescence by the vendor is a concern. Although stand alone MSDE does not require licensing, connecting MSDE to a full SQL Server database does require a license.
Microsoft Access	Microsoft Access is the database currently used in FIREMON and in FEAT version 1.2. Access will not be considered as a host database, but could be used to interact with FFI data via linked tables or Access Project in MSDE. **Advantages:** Access is well known and many agencies already have the software on their computers. • **Disadvantages:** Security issues, limited size of Access databases, and limited multi-user support. Access is not a client-server application. Microsoft consistently hints that they will replace Access with MSDE. Access PDS support is poor. Pocket Access is a version of Access 95 (a 16 bit application) which will limit PDA performance. The only means of data transfer from Pocket Access is ActiveSync,

Database Option	Comments
	which has been a major point of failure in FEAT 1.2.
Oracle Lite	Will be explored.
Oracle or SQL Server (data roll up option)	Because of cost and systems management overhead, these options will not be considered at this stage. They may be considered in the future for use as a centralized (roll up) database.

Data Model

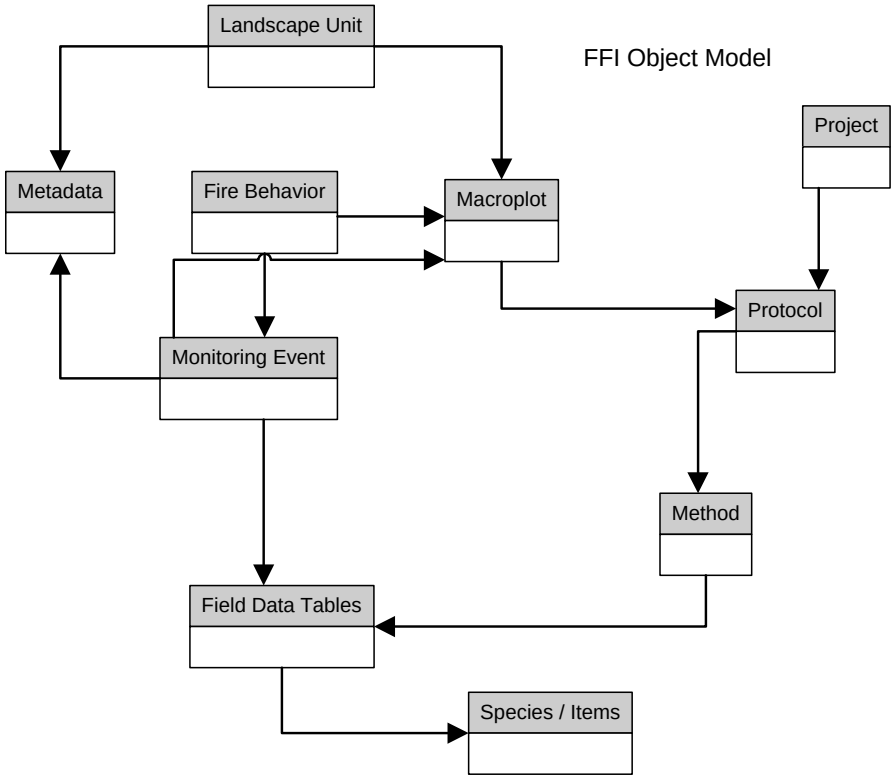


Figure 5 - Data Model

The above diagram illustrates the primary objects within FFI. The objects and relationships are defined as follows:

- Project – overall agency monitoring program
  - Projects have protocols
- Protocol – a suite of sampling methods
  - Protocols have methods
- Method – measurements taken in the field
  - Related to macroplots
- Landscape Unit – area of interest
  - Contains one or more macroplots
- Macroplot – sampling site and description
  - Contains one or more protocols
- Field Data Tables – collection of data from methods
  - Can have species data and/or other items of interest
- Monitoring Event – Record of data collection (date and time)
- Linked to Macroplot and Field Data Tables
- Species / Items – Species Scientific Names and Codes / Codes for other items

    - Species / Item data contained in Field Data Tables
- Fire Behavior – Measurements of specific fire event
    - Linked to Monitoring Event and one or more Macroplots
- Metadata – Description of sampling methods
    - Linked to Monitoring Event and Landscape Unit

Implementation

Documentation

Documentation for FFI will include an editable electronic and hardcopy manual that thoroughly describes the process involved in designing, implementing, and assessing the results of a monitoring program. The manual will be similar to what currently exists for FIREMON but will incorporate additional materials relevant to FEAT and information for new FFI components and concepts. The FFI documentation will also describe the philosophical differences of the FEAT and FIREMON systems and discuss the integration of the two systems.

The manual will include a description and/or instructions regarding eight main components: 1) installation and maintenance/upgrades of the FFI software package including instructions for data migration from FIREMON and FEAT, 2) discussion of developing a sampling project design, 3) description of each field method, 4) instructions for data entry, 5) directions for data analysis, 6) directions for development of new protocols, 7) GIS applications, and 8) exchanging FFI data with other applications.

1) The installation, operations and data migration guide may be distributed as a separate document addressing just the installation and migration of existing FEAT and FIREMON data. The installation guide will include FFI hardware and software specifications, sources for obtaining the FFI software, as well as FAQs and other available sources of assistance. The guide will address basic FFI database administration including adding new users, assigning user privileges, managing stored queries and database backup.

2) The sampling design documentation will describe processes that FFI users can employ to develop a monitoring project. Discussions will include guidance for using a statistical or non-statistical sample design, including the costs and benefits of each design; sample size; plot locations; and plot sampling methods.

3) Each field method will be thoroughly described in the sampling methods section of the documentation. The description will include a standard or suggested approach to each method with detailed instructions for applying the method at the sample site and directions for understanding and overcoming common problems in the field. This component will also describe what information will be stored in the metadata table and fire behavior tables.

4) Step-by-step directions will describe data entry (including importing legacy data, data from other applications, such as LANDFIRE, or new data into an existing dataset), editing and deleting information from the database, and instructions to save, back-up, and protect the database files.

5) The data analysis section will discuss options for exploring data either in summaries (by plot or stratum) or, when applicable, use of statistical tests. This component will tie the data analysis back to the sampling design documentation to avoid inappropriate use of statistical tests.

6) The Protocol/Method Builder documentation will address using the Protocol/Method Builder to retrieve different protocols and to define new protocols using combinations of existing field methods. The documentation will instruct the user how to define new field methods in terms of the field data to be collected as well as the physical plot layouts.

7) The GIS guide will instruct users how to use the custom FFI GIS tools within the ESRI ArcMap environment, to spatially define monitoring or sample units, strata, using typically available GIS data sets. The GIS documentation will describe the use of GIS tools to select plot locations (used in conjunction with the sampling design document), stratify plot locations and select plots for analysis, and generate maps displaying monitoring results and trends. The GIS guide will also instruct users how to apply the DNBR method for assessing burn severity and how to interact with the FRCC mapping tool. The GIS documentation will assume that users have some knowledge of GIS and ArcMap.

8) The data exchange documentation will provide users with detailed instructions for extracting and exchanging data with the specific applications supported by FFI such as LANDFIRE and FRCC. Documentation will also address the development of data sets that use common data exchange formats. The documentation will contain all required steps including identification of individual or groups of plots, identification of variables to be included, the steps for completing an intermediate or summary analysis, and generation of the physical exchange data set. Both tabular and spatial data exchange will be addressed. Data import using spreadsheet and table-based import tools in FFI will also be documented.

Where necessary, references will be supplied in the text of the documentation. Numerous references, including those not in cited in the text, will be supplied. References may include other training resources, especially on-line resources for GIS training. Finally, a glossary will be provided.

The FFI documentation will also be converted to a hypertext document to allow users to interactively use the documentation on a local basis or via the Internet.

The applicable set of the existing FEAT documentation will be merged, and where necessary rewritten, with the FFI documentation set. The current NPS Fire Monitoring Handbook (FMH) will be referenced in the documentation and may be distributed with the FFI documentation. There will be no substantial changes made to the FMH documentation by the FFI project.

Training

FEAT training will be incorporated into Rx80 and Rx92 curriculum. FIREMON training is provided through workshops held throughout the year. The training materials for the two systems will be integrated into the FFI curriculum, which will also include new components and concepts not currently in FEAT or FIREMON. These materials will cover all aspects of the documentation and provide visual presentations (PowerPoint), examples, worksheets and training data. The developers will identify the feasibility of producing a Web-based training curriculum and, if feasible, publish it to the Web.

The FFI training curriculum will be presented in at least one train-the-trainer workshop. The goal of the workshop will be to develop a cadre of FFI instructors who will conduct FFI workshops once FFI is released and distributed to agencies. The training materials will be of sufficient quality and depth that the FFI training can be incorporated into the National Wildfire Coordinating Group fire training curriculum.

A core set of training data will be developed to support training as well as self-study training. The training data will include all typical GIS layers, field data, and analysis results.

Because each agency has unique monitoring guidelines and requirements, FFI training will ultimately be the responsibility of agencies. The developers will provide the training materials, curriculum and initial workshop; agencies will then provide continuing FFI instruction. This will allow FFI to be applied in the most efficient and useful manner across agencies.

As FFI is modified, documentation and training materials will be updated as necessary. Provisions will be made to support the distribution of the updated materials including Web-based distribution. Distribution of updated materials may also include providing the materials, as digital files, to FFI agency coordinators and selected users, or to all known users. The Business Leads will determine the approach that will be used for primary and maintenance documentation distribution.

System Deployment

The detailed FFI system deployment procedures will be developed by the Business Leads during the development project. Deployment will include communication regarding FFI development and availability. Communications can be started early in the FFI development process to support agency and user input to the FFI development as well as providing pre-release information so that users can prepare appropriately for implementing FFI.

It is expected that an FFI website started during the development phase can support initial user involvement, deployment, and ongoing user support. The website will be the primary means for deploying FFI. Internal agency intranet distribution will also be supported by participating agencies using their internal systems. In order to maximize

FFI's availability it may also be available in conjunction with other applications such as LANDFIRE and FRCC.

CD-ROM distribution, for those sites with limited Internet access, will be supported by each agency. A master copy of FFI application will be provided to each participating agency.

All of the system documentation will be distributed with FFI including the installation guide, which addresses the system requirements and the installation steps. FFI deployment will include initial installation scoping and trouble shooting support by the FFI development team. Help desk support will be provided to assist users with FFI implementation. Deployment and implementation support issues will be logged using a tracking system (database) so that consistent problems with FFI application and documentation can be easily identified and remedied. The tracking system will also provide essential information for documenting FFI's performance and user experience.

Website

An FFI website will be established to promote communications within the user community, support the system deployment, and provide user support services. The Business Leads will determine who will be responsible for the site and where it will be hosted. The alternatives for the website include hosting and operation by a contractor, hosting and operation by an agency, or hosting of the site at an existing topical site such as FRAMES or fire.org.

The website will be an active tool for FFI communications. Initial management and updating of the site may be supported by the development team during the development stages including the initial release and deployment. The website will include a number of FFI resources including FFI installer downloads, documentation downloads, references to additional documentation, FFI update and status reports, and a user forum to discuss successes and problems with FFI. Following deployment, the management of the website may be shifted to an agency or other entity as determined by the Business Leads.

Ongoing Maintenance

Initial FFI maintenance will occur over the first maintenance period after the system release. User response, testing, and experience will be used to identify system defects that should be addressed. The web forum and installation and help log will be used to identify bugs that need to be addressed. Business Leads will determine which bugs to address. Bug fixes will address existing system functions and will not address any system scope changes or modifications.

The help desk will be maintained on a part-time basis for the first maintenance period. Help support will be set up to include use of the FFI website forum as well as telephone

help desk support. Help calls and issues will be logged in the tracking system in order to identify system problems and document maintenance and support activities. The tracking system can also be used to identify and document requests for major changes to the system.

A major upgrade to FFI is anticipated at the three- to five-year interval and will be directed by the Business Leads. The upgrade will address FFI changes due to technology changes such as different or new portable devices. The upgrade will also address changes resulting from agency IT policies. The upgrade will include major changes and enhancements to FFI based upon user experiences. The tracking system and user community input will be used to identify changes and enhancements.

APPENDIX

To support the conclusions and plans outlined in this document, the following white papers and references are included:

1. FEAT on MySQL Rev. 9; White Paper, Spatial Dynamics
2. Importing XML Data for FFI Analysis, John Caratti
3. Comparison of Sun Java and Microsoft .NET, White Paper, Spatial Dynamics
4. On Windows Vista v .91, White Paper, Spatial Dynamics
5. XML Generation, article, unknown